Nowcast for the Next Generation Navy

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LONG-TERM GOALS

The long-term goal is to develop a high-resolution data fusion system to blend an ensemble of highly perishable, on-scene environmental data together into a consistent, integrated picture of the "now" environment. The system will provide a common environmental situational awareness directly to the warfighter for areas surrounding the battlegroup and over target locations. The situational awareness of weather hazard information is intended primarily to support naval aviation in time critical strike missions but may also be used in navigation, cruise missile weaponeering, and for ship self defense. The nowcast system will be owned, operated, and its quality assurance maintained by the METOC office. Products will be web-based and warfighter-defined for ease of interpretation.

OBJECTIVES

The specific objectives of this project are to design and develop a prototype client / server nowcast data fusion system, to develop example products using a wide variety of data sources, and to get end-user buy-in through a series of high-level briefings and through an Integrated Product Team (IPT) process that is designed to ensure the products developed are useful to the warfighter.

APPROACH

NRL Monterey will leverage its multi-scale operational atmospheric data analysis and assimilation expertise and existing forward deployed METOC Tactical Environmental Database System (TEDS) to provide the data and background fields for a nowcast system. Traditionally, the bulk of atmospheric data has been collected at the synoptic times of 00Z and 12Z to support central site data processing and the numerical weather prediction schedule. To meet the challenge of utilizing METOC data available at asynoptic times collected by forward-deployed units, NRL has developed the Coupled Ocean/Atmosphere Mesoscale Prediction System – On-Scene (COAMPS-OS), that includes TEDS, and is now being tested at the Navy METOC Regional Centers. In nowcast, we would like to use data from non-traditional sources and data collection networks focused around the battlegroup (e.g., AEGIS SPY-1 Tactical Environmental Processor (TEP) for weather radar, shipboard measurements, satellite, and unmanned aerial vehicles (UAV)) so fine-scale weather features can potentially be resolved. This requires us to adapt machine intelligent feature detection and artificial intelligence (AI) data fusion techniques to create an automatic environmental data fusion engine for nowcast. In addition, nowcast will use established web-based product dissemination and display technology to overcome Fleet firewall policy limitations and minimize end-user training issues. The nowcast client software

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application will be configurable to allow the warfighter to tailor the results to their specific requirements. The nowcast capability will periodically be demonstrated during operational exercises.

Another principal effort will be devoted to the development of high-level support and end-user buy-in to nowcast. In addition to the technical assessment of the environment as proposed, it is important not to lose sight of the end-state user needs and requirements (METOC community and warfighters: pilots, ship captain, etc.). To this end, a series of high-level briefings and meetings to senior Navy decision makers in the aviation, surface warfare, and METOC communities have been on-going to expose nowcast and generate support. The success of the project is related to acceptance by the end-user. Without a feedback mechanism between the S&T process and the end-user, it is possible to be scientifically and technically correct, but produce results that are not useful. To this end, we propose to have a well-defined involvement of selected end-state users in the effort through an IPT process.

Another key element of the approach to developing a nowcast system is leverage of other projects at NRL and of existing efforts in other governmental agencies. The NRL base program supports a research project to develop automatic product verification technology for nowcast and to apply the techniques to determine how well in space and time the atmosphere should be sampled to support accurate descriptions of the cloud field and electromagnetic (EM) propagation conditions, and to determine the minimum scale of features that need to be characterized to support carrier air operations. To improve the diagnosis of the three-dimensional cloud field, the NRL base project has implemented components of the University of Oklahoma's ARPS Data Assimilation System (ADAS). In a related area, not funded by ONR, NRL has a major Ceiling and Visibility (C&V) nowcast product development funded by three elements: FAA, NASA, and Navy (CNMOC and SPAWAR), to provide C&V nowcast product. The product will be tested at the Naval Pacific Meteorology and Oceanography Center, San Diego, at the FAA Air Route Traffic Control Center near Los Angeles (Palmdale), and at the Aviation Weather Center at Kansas City, MO. In addition, nowcast will benefit from a Deputy Undersecretary of Defense (S&T) project called Smart Sensor Web to provide weather data from denied areas in the target zone. The Weather Web component of Smart Sensor Web that NRL is involved in is focused on assimilating data collected using innovative techniques from test sites located in western Massachusetts and Ft. Benning, GA.

WORK COMPLETED

A prototype nowcast system was designed, coded, and demonstrated. Nowcast uses a four-tier internet architecture consisting of a Java applet for an end-user graphical interface (Tier 1), a web server-based servlet engine and database to support the applet and maintain end-user context (Tier 2), a nowcast product generation loop to provide data sets and images tailored to end-user session requirements (Tier 3), and the COAMPS-OS, TEDS, and ADAS data assimilation system as a back-end (Tier 4). Nowcast leverages software developed for the NRL Atmospheric Variational Data Assimilation System (NAVDAS) for data quality control and the NAVDAS data structures are used to provide a commonality among data handling software. The nowcast applet is shown in Figure 1 and it supports the display of a default folder containing multiple products in tabbed windows on a common map, including satellite imagery, and a time history of the products. The applet also displays real-time station (METAR) data with the ability to click on a station to display a time-series of various parameters, and the applet allows the user to redefine the map region area by zooming in and out based on a bounding box drawn with a mouse. Buttons for several other features are shown in Figure 1 but are not implemented yet.

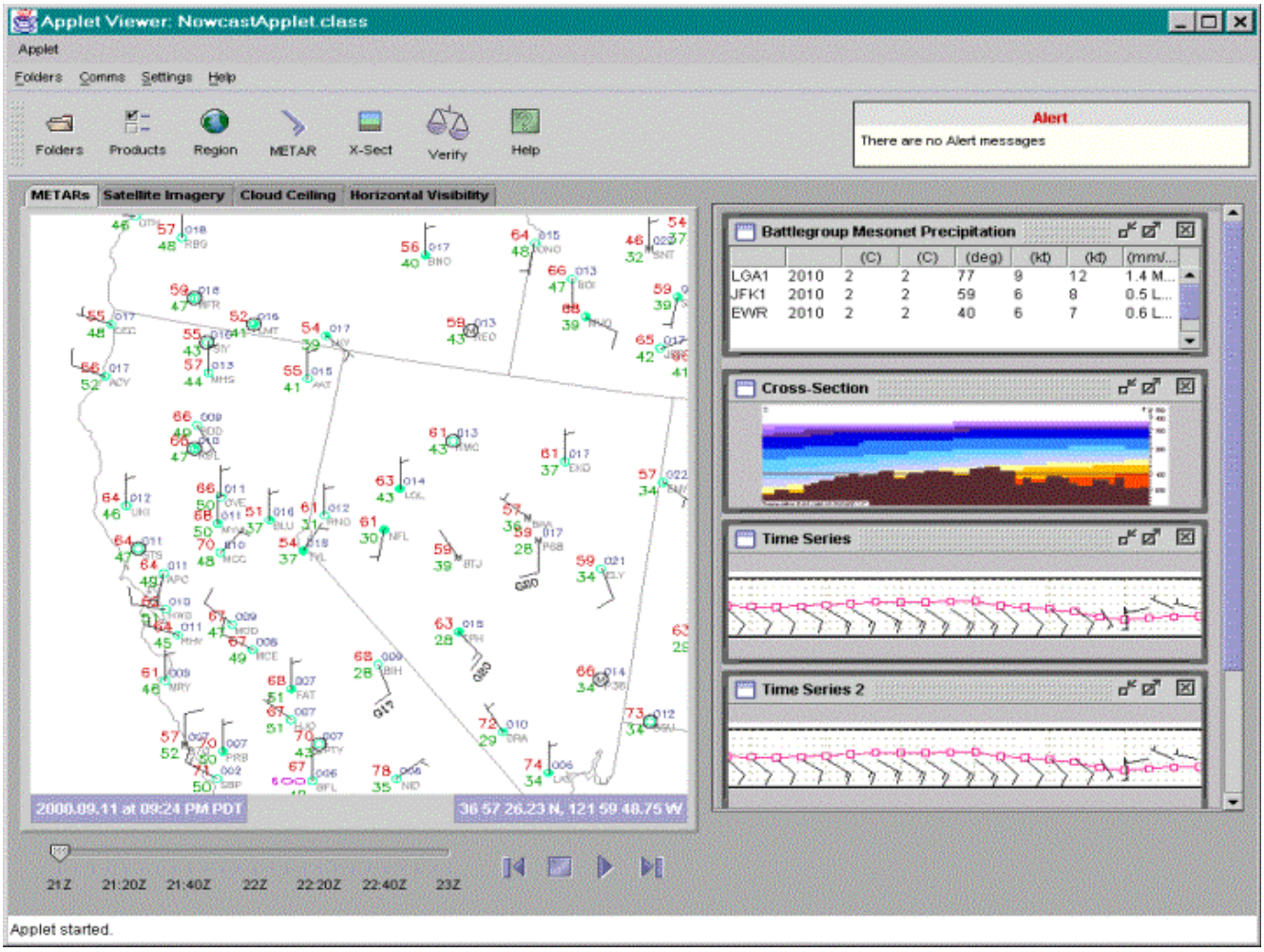

Fig. 1. Nowcast Java Applet.

Work was also started at the National Center for Atmospheric Research (NCAR) on processing and analyzing a large amount of radar data collected during the TEP demonstration cruise aboard the USS O'Kane. Figure 2 shows a preliminary result from NCAR of the TEP data interfaced to their storm tracking algorithm called Titan. Titan identifies the current storm position (cyan polygons) and projects the position 30 min. later (magenta polygons) based on an automatic analysis of features, including gust fronts and convergence lines, and extrapolation. In this example, ship movement has not been accounted for. However, it is an exciting result nevertheless for of a couple of reasons: this is the first time the Navy has collected shipboard weather radar data through a tactical system (AEGIS SPY-1), and this is the first time at-sea radar data has been interfaced to automated storm tracking software. This demonstration shows promise that nowcast can utilize radar data to significantly improve automated thunderstorm detection and avoidance at sea.

Additionally, this year a series of briefings were developed and presented to high-level decision makers that resulted in an endorsement of nowcast from the Commander, Third Fleet, and a presentation at and endorsement from the CAG WARCOM held August 2000 at the Naval Strike and Air Warfare Center (NSAWC), Fallon NV. The first nowcast IPT was also held this year at NRL Monterey. The IPT was intended to foster a nowcast effort that best matches science and technology with the needs of the warfighter. The IPT was attended by a mix of warfighters, engineers, scientists,

managers, and METOC decision makers and resulted in a lively exchange of information, requirements, and concerns about the role, design, development, and fielding of an operational nowcast capability.

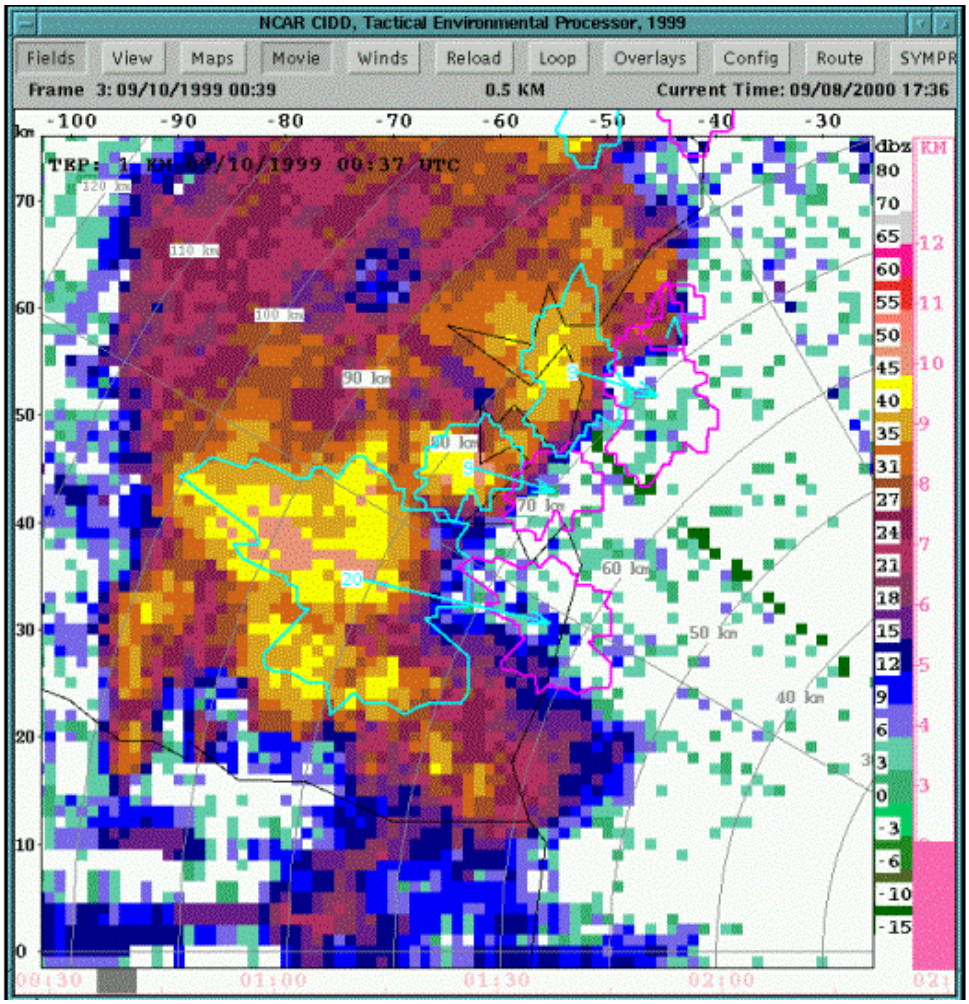

Fig. 2. TEP reflectivity data from 10 Sept. 1999 with range rings at 10 km intervals.

RESULTS

Several technologies were investigated and a combination of a Java applet and servlets and a Lightweight Directory Access Protocol (LDAP) database was chosen to meet the requirements for nowcast. Five servlets were completed this year and several other servlets will have to be developed in the future. In addition, the software needs to be developed for the METOC applet used to maintain configuration and quality assurance for the nowcast system. Additional interfaces to other than the NAVDAS data streams need to be developed to take advantage of other data sources.

The IPT reinforced the warfighter's priorities for data fusion in the target areas, enroute, and in the carrier launch and recovery areas. Nowcast needs to supplement existing METOC forecast assets with an automated, continuously updated capability. Three-dimensional graphical products are required for specific uses and some form of nowcast products should be available in the cockpit over link 16.

The end-user buy-in effort has resulted in an increasing acceptance of the nowcast concept by N096, ONR, CNMOC, SPAWAR, and the operational Navy as evidenced by letters of endorsement and invited briefings.

IMPACT/APPLICATIONS

Nowcast is the pinnacle of a telescoping strategy to provide environmental products tailored to the needs of the warfighter, from the global scale to the tactical scale in both time and space. Nowcast also represents a paradigm shift from products that are briefed and interpreted by METOC personnel to products that are easily accessible, automatically updated, and tailored for interpretation directly by the warfighter. Nowcast enhances the role of METOC support by supplementing the existing forecast capability with automated, short-term (less than 2 hrs) products thus freeing the forecaster to concentrate on the longer-range projections for planning and evaluation purposes.

TRANSITIONS

This is a new project with a transition envisioned in the 2005 time frame to the 6.4 Navy Integrated Tactical Environmental Subsystem (NITES) program at the Space and Naval Warfare Systems Command (SPAWAR) PMW 185.

RELATED PROJECTS

The Tactical Environmental Processor (TEP) development and demonstration project at ONR is a key component of nowcast to collect weather radar data from the AEGIS combat system on a not to interfere basis.

Another major component of nowcast development is the project in the NRL base program (BE-35-2-56) to develop cloud diagnostic algorithms and verification software for the nowcast system.

The tri-service (FAA, NASA, and Navy) C&V product developed by NCAR and NRL Monterey is the first nowcast product to go into production.

The Weather Web project of the Deputy Undersecretary of Defense (S&T) is important to provide denied area weather data to nowcast.

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